Mathematical and Numerical Tools for Geotechnical Engineering Problems (250MEG001)

General Information

School	ETSECCPB
Departments	Departament d'Enginyeria Civil i Ambiental (DECA)
Credits	5.0 ECTS
Programs	MÀSTER UNIVERSITARI EN ENGINYERIA GEOTÈCNICA (pla 2025)
Course	2025/26

Main teaching language at each group

- Group 10Q1 Spanish (Q1)

Faculty

Responsible Faculty: Michele Starnoni
Faculty: Michele Starnoni, Jean Vaunat

Objectives of Education

To conceive soils and rocks as porous media governed by Solid and Fluid Mechanics.
To characterize the geological environment and its interaction with civil works.
To formulate and implement Finite Element and Finite Differences numerical models with the objective to analyze the processes that govern ground response, to interpret field information and to predict soil response.

* To recognize the problems in Civil Engineering.
* To relate the problems in Civil Engineering to the characteristics of the geological environment.
* To conceptualize the problem in Civil Engineering in order to analyze, model and solve them.
* To apply continuum media concepts to analyze and model problems in Civil Engineering.
* To apply numerical techniques to solve Civil Engineering problems.

- Advanced mathematical concepts. Element of vector calculus and differential equations.
- Continuum in soils and rocks. Eulerian and Lagrangian description.
- Elements of Solid Mechanics. Linear elasticity.
- Fluid mechanics.

Total hours of student work

		Hours	Percentage
Supervised Learning	Large group	45.0 h	100.00 %
	Medium group	0.0 h	0.00 %
	Laboratory classes	0.0 h	0.00 %
	Guided Activities	0.0 h	0.00 %
Self Study		80.0 h	

Contents

Mathematics and physics concepts

Concepts of vectors and tensors. Definitions of fields. Derivation Changes in coordinates. Eigenvalues and eigenvectors
Differential operators: Del operator, Gradient, divergence and Laplacian in Cartesian and cylindrical coordinates. Integrals in space. Derivation under the integral sign. Integral theorems. Special functions: Heavyside and Dirac

Description of movement

Equations of movement. Descriptions Euleriana and Lagrangiana. Concept of material derivative. Balancing equations.
Equations of movement. Exercises

Stress-strain

Mechanics of the solid. Constitutive equations. Tensions and deformations. Mohr's circle.
Description of the deformation tensor. Hooke's law. Elasticity and plasticity
Lineal elasticity. Plasticity
Exercises on stress and strain

Numerical methods

finite differences, finite volumes, finite elements

Teaching Methodology

The subject consists of 4 hours per week of classroom lessons in the classroom (large group)

Each class combines theoretical knowledge with a large number of learning exercises to work individually or in groups.

Support material is used in the format of a detailed teaching plan through the ATENEA virtual campus: contents, programming of assessment activities and directed learning and bibliography.

Although most of the sessions will be given in the language indicated, sessions supported by other occasional guest experts may be held in other languages.

Grading Rules

(*) The evaluation calendar and grading rules will be approved before the start of the course.

The qualification of the subject is obtained based on the continuous assessment qualification.

The continuous assessment consists in doing different activities, individual and group, of an additive and formative nature, carried out during the course (inside and outside the classroom).

Evaluation tests consist of a set of application exercises

Test Rules

Failure to perform a continuous assessment activity in the scheduled period will result in a mark of zero in that activity.

Bibliography

Basic

- Oliver Olivella, X.; Agelet de Saracíbar, C. Mecánica de medios continuos para ingenieros. 2a ed. Barcelona: Edicions UPC, 2002. ISBN 848301582X.